About an Analytical Matrix

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ABSTRACT – The analysis of twentieth-century music calls for appropriate methods, other than traditional ones. It is necessary to create an analytical system of synthesis that brings together the criteria of traditional musicology, computational musicology, mathematized musicology, or more recently the analysis of interpretation. For the elaboration of the analytical matrix, I started from the idea that one needs a fixed, stable part (a framework) found in all analyses, as well as an adaptable variable part. Musical morphology can be thought of as a first level where the parameters of the sound material are inventoried. Syntax represents the highest level of its organization. Like any theory, the proposed method of analysis is to be validated through its practical application. I have chosen as an example a piano miniature from the creation of Anatol Vieru – *Sfârleaza* [*The Spinning Top*]. This particularly attracted my attention due to the suggestive force of the movement achieved with simple means and the beauty of its composition. This is among the works that prepared the ground for shaping the mature style and innovative musical thinking that places Anatol Vieru among the important composers who influenced the composition of the 20th century. The analysis example was specifically chosen to use a good part of the available working options and demonstrate the effectiveness of the method. The matrices designed for both morphology and syntax ensure the stability of the method by not leaving any important aspect out of the analysis. The freedom of movement inside them bestows an eclectic aspect to the approach, but most of the time, it gives everyone the opportunity to choose the way of working that is more familiar to them.
Keywords: analytical matrix, musical analysis, parameters, Anatol Vieru.

1 Introduction

Music analysis is a vast and ever-changing field, moving in step with music composition. The twentieth century offers us perhaps the greatest diversity of musical styles and writings. The analysis of these compositions requires appropriate methods, other than the traditional ones used for tonal-functional music, devised by Heinrich Schenker, Hugo Riemann, Jan LaRue or others. Devising a single method based on a single set of criteria is an unrealistic aspiration. The solution is to create a synthesis analysis system that brings together the criteria of traditional analytical musicology, of computational musicology, of mathematized musicology, or more recently, of performance analysis. Only together, they may cover all aspects of a musical opus or a corpus of works. The present paper brings to your attention such a multi-criteria analysis. The method to be presented below was initially developed for the analysis of keyboard works composed by György Ligeti. Nevertheless, it can be adapted to a wide variety of creations. In the present work its application is demonstrated on a piano miniature by composer Anatol Vieru.

2 The Analytical Matrix

For the development of the analytical matrix, I started from the idea that we need a fixed, stable part (like a skeleton, or framework) that can be found in all analyses, as well as a variable part adaptable to each style. I was inspired by the stylistic analysis grid proposed by Jan LaRue – SHMRG (*Sound, Harmony, Melody, Rhythm, Growth*)[1] or in the Romanian version proposed by Valentina Sandu-Dediu SAMRE (*Sonoritate, Armonie, Melodie, Ritm, Evoluție*)[2]. This suggested the idea of creating algorithms, but it bears two disadvantages: it is conceived in the American system of theoretical thinking, which is different from the European one, and it does not propose the technical means of analysis. Closer to us is Pierre Boulez, whose musical thinking derives from the European tradition. In *Penser la musique aujourd'hui* (1963), the author advocates the algorithmic view and, in addition, he defines the parameters with mathematical rigor and classifies them according to the linguistic model. In another order of ideas, the structuralist-linguistic perspective led me

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[1] Sandu-Dediu, *Studii de stilistică şi retorică muzicală*, 15.
[2] Sandu-Dediu, *Studii de stilistică şi retorică muzicală*, 15.

to organise the categories on two levels: morphologically – the analysis of inflectional forms, and syntactically, respectively – setting the elements in relation.

Musical morphology can be thought of as a first level where the sound material is inventoried. The morphological categories are the following: the intonational systems; the rhythmic systems; the dynamic system; the timbral systems; the temporal (metric) system. Syntax represents the highest level of organization of the sound material. There are four syntactic categories ordered in the sequence from simple to complex: monody (monophony); harmony (homophony); polyphony; heterophony. The musical form is the consequence of the syntactic organization of the sound material and constitutes a resultant, the third level of the analysis. In each stylistic era, the symbiotic functioning of morphology and syntax generated a specific typology of musical forms. The twentieth century offers us a multitude of combinations between different morphologies and syntaxes. They generate a diversity of musical forms from classical ones with rigorous architecture to the most recent ones.

2.1. Morphology

A composition lies, from an analytical perspective, at the junction of the systems mentioned. In structuring the analytical matrix, for the morphological part, I started from the four parameters of the musical sound (pitch, duration, intensity and timbre). In Pierre Boulez's view, these acquire organizational functions. Thus, pitch and duration have an integrating role and intensity and timbre have a coordinating role. I decided to use the following parametric categories:

i. The sound material
ii. Melody
iii. Rhythm
iv. Metre
v. Tempo
vi. Dynamics
vii. Timbre

These can be joined, optionally (depending on the context) by:

viii. Texture
ix. Ostinato

The first five parameters are quantifiable (derived from the notation of pitch and duration, respectively from the metronomic value), the following cannot be quantified. Depending on the characteristics of the work, other parameters such as texture, cluster or ostinato can be taken into account.

i. "The term material implies the idea of something pre-existing to the creative and organizing thought, and which the composer must master by keeping a distance from it."[3] The assertion is drawn from the definition proposed by Michel Chion. My approach starts from this idea. The first step consists in detecting the intonational system used by the composer. The tonal, modal diatonic or chromatic, dodecaphonic or hyper-octave character of the musical scale or scales used is highlighted, as appropriate. Obviously, this stands true for music written in classical notation. For notated music that uses other graphics or for electronic music, this stage is solved with computational means.

ii. Melodic organization is generally based on cells, motifs, themes, series that are subject to transformations. For their analysis, I propose the following classification of patterns:

a) Fixed pattern – reiterated
   – singular transposition
   – pattern and sequences
b) Mobile non-evolutionary pattern – inversed
   – recurrent
   – simultaneously recurrent and inverted
c) Mobile evolutionary pattern – interval variation
   – rhythmic variation
   – simultaneous intervallic and rhythmic variation
   – addition
   – elision
   – fragmentation

To be noticed the presence (or absence) of ornaments and their melodic role.

iii. The rhythmic typology is very diverse and is generally associated with melodic writing according to the stylistic customs of the era or composer. We note the following types:

a) Proportional rhythm
b) Asymmetric rhythm
c) Irrational rhythm (exceptional divisions)

[3] "Le terme de matériau implique l'idée de quelque chose qui préexisterait à la pensée créatrice et organisatrice, et que le compositeur doit maîtriser tout en gardant ses distances avec lui.", in: Bosseur, *Vocabulaire de la musique contemporaine*, 85.

d) Rhythm with added value
e) Rhythms of folklore origin (see aksak)
f) Non-retrogradable rhythm (rhythmic palindrome)
g) Metric rhythm (framed in measures)
h) Free rhythm (independent of measures)
i) Chronometric rhythm (for electronic music)
j) Duration series
k) Polyrhythmy

For the duration series, I embrace Pierre Boulez's classification proposal. He indicates three categories:

- Fixed series – they preserve proportions by multiplication or division (geometric progression);
- Mobile non-evolutionary series – they change proportions by adding or subtracting a constant value (arithmetic progression);
- Mobile evolutionary series – they change the proportions of the original by a variable value (function).

iv. Along with rhythm, another parameter to analyse is the metre. We use the following classification:

a) Regular metre
b) Irregular metre
c) Polymetry

v. Tempo is also a temporal parameter. Pierre Boulez's classification[4] proposal is used in this case as well:

a) Fixed tempo – fixed standard
b) Mobile tempo
   1. directed; between fixed standards (accelerando, ritardando) or, at most, between fixed standard and Non-fixed standard
   2. undirected; variable standard – defined chronometric field
      – undefined chronometric field

vi. Dynamics is, along with timbre, a qualitative, subjective and relative parameter with no specific measurement unit. There are two categories:

a) Punctual dynamics – related to nuances
b) Linear dynamics – intensity changes

vii. The last parameter on the morphological level is timbre. It became important as an element of musical language only in the 20th century. At that time, it was enriched, on the one hand, by developing the instrumental technique (modes of attack or sound emission) and, on the other, by including in the music the sound produced or processed electronically and other ambient sounds and from nature. There is:

a) Monochrome timbre (an instrument or a family of instruments)
b) Polychrome timbre (combinations of timbres)

Timbre changes play an important role in phrasing and form articulation. Modes of attack, registers, doublings, pedals (on the piano) and others resulting from the instrumental technique can be detected from the score. The others are left to be discovered aurally. The spectrogram may also highlight timbral changes and is a significant support.

In addition to the parameters presented above, the following also may be subject of analysis:

viii. Texture was originally defined in relation to micropolyphony, today the term is used with a greater degree of generality. The classification of textures is based on density criteria along a vertical axis (the relationship between sound planes), respectively along a horizontal axis (the relationship within a sound plane). Vertically there are the following types:

a) Compact textures – sounds belonging to all sound planes overlap in a chromatic cluster;
b) Porous textures – the sounds form a chord that also contains intervals greater than the second;
c) Polarizing textures – the sound planes embrace the extremes of the instrumental range.

In the horizontal direction, density conveys information about the *continuity* or *discontinuity* of the sound plane. If we refer to the global sound flow, its continuity can result from the superposition of several discontinuous sound planes. Recall that Iannis Xenakis defined and quantified sound density[5]: $\lambda = \frac{number\ of\ sound\ events}{time\ unit}$. The number of sound events is the number of sounds emitted in a chosen time interval. The time unit is chronometric (seconds, minutes) for electronic music, but can be adapted so that the time unit is metric (a measure or a beat within a measure). The formula proves useful in numerous cases.

ix. Ostinato was defined by Gioseffo Zarlino in 1558 (in *Instituzioni Harmoniche*). The concept has evolved over time, the technique of ostinato diversifying and adapting to musical styles of all eras. In *L'ostinato procédé musical universel*, Laure Schnapper[6] classifies ostinatos as follows:

a) Rhythmic ostinato
b) Melodic-rhythmic ostinato

[4] Boulez, *Penser la musique aujourd'hui*, 54.
[5] Xenakis, *Musiques formelles*, 37.
[6] Schnapper, *L'ostinato, procédé musical universel*, 233.

c) Harmonic ostinato
d) Transformational ostinato

For the effective realization of the analysis, we have at our disposal a multitude of musicological but also mathematical or IT tools. For visualizing sound material and chords, the representation on the chromatic circle is very useful. In the same way, we can use the representation of melodies or rhythms in a system of orthogonal axes (Cartesian coordinates in the plane). In this case, the horizontal axis is the time axis and the vertical axis is the pitch of the sounds. The visualization and analysis of the dynamics, respectively of the timbre, is performed with the help of sonograms and spectrograms. There are applications such as *Acousmographe, Audacity, Sonic Visualiser* and others, each with their own advantages and disadvantages.

2.2. Syntax

If in the morphological analysis we analysed the score at the micro level of details, the syntax sends us to the macro level of the music. Here we are interested in the typology and characteristics of each present type. The results obtained from the morphological analysis are integrated to highlight the structural articulations necessary to determine the shape. We return to the four large classes of syntaxes:

i. Monody (monophony) – "horizontal distribution of sound objects" (Ștefan Niculescu[7]) with a generalization of content, independent of era and style.
ii. Harmony (homophony) – the vertical distribution of sound objects attached to the sound system. It can be tonal, modal, polycentric, serial and even spectral. It is, as the case may be, functional or just inherent in writing in other syntaxes.
iii. Polyphony – "oblique" distribution – the relation of simultaneous sound planes.
iv. Heterophony – characterized by the alternation of "nodes" and "anti-nodes" modelled on a vibrating string.

Analysis tools are the same as above. Linear representation for a sound plane, circular representation for chords. For the analysis of polyphony, mathematical modelling can be used with the help of the cyclic group of geometric transformations (depending on the complexity). Sonograms and spectrograms are useful in confirming (or disproving) and ranking the articulations.

We reach the last stage of the analysis by establishing the architecture of the form and belonging to a musical genre. Formal evolution presents a high degree of ambiguity, therefore it needs clear benchmarks. These can be extracted from the score, from the graphic representation, from the sonogram where the articulations of the form are highlighted.

The simplified scheme of the working method is as follows (Figure 1):

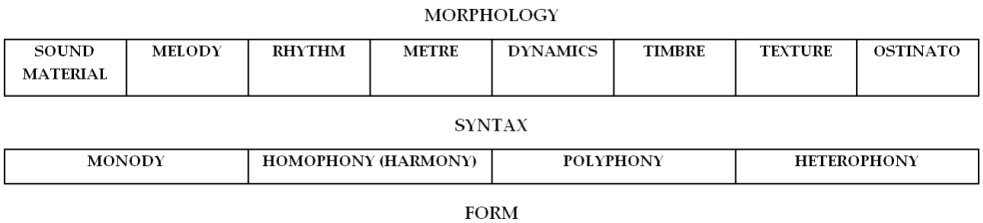

Fig. 1. Simplified Diagram of the Analysis Strategy.

Detailed examples for both morphology and syntax can be seen below (Figure 2a, respectively Figure 2b). It is easy to see that each parameter is analysed independently. Different coloured arrows mean that we can use different ways of solving.

[7] Niculescu, "O teorie a sintaxei muzicale".

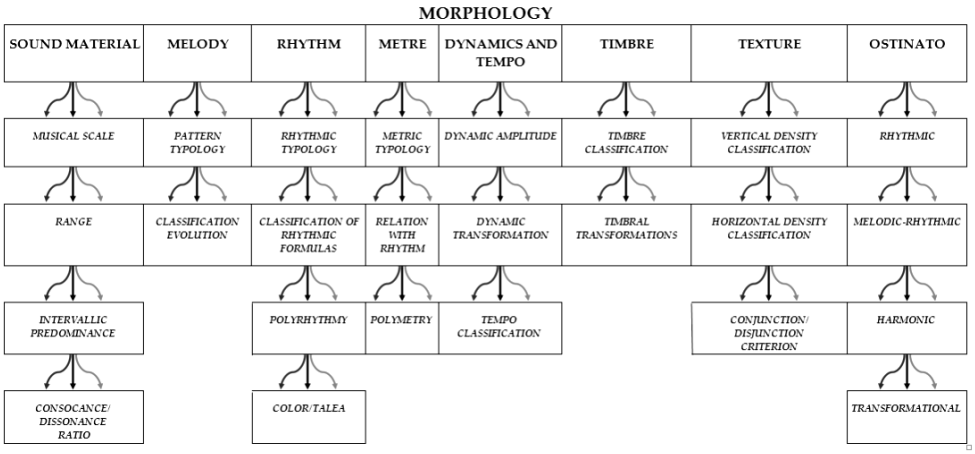

Fig. 2a. Morphological Diagram.

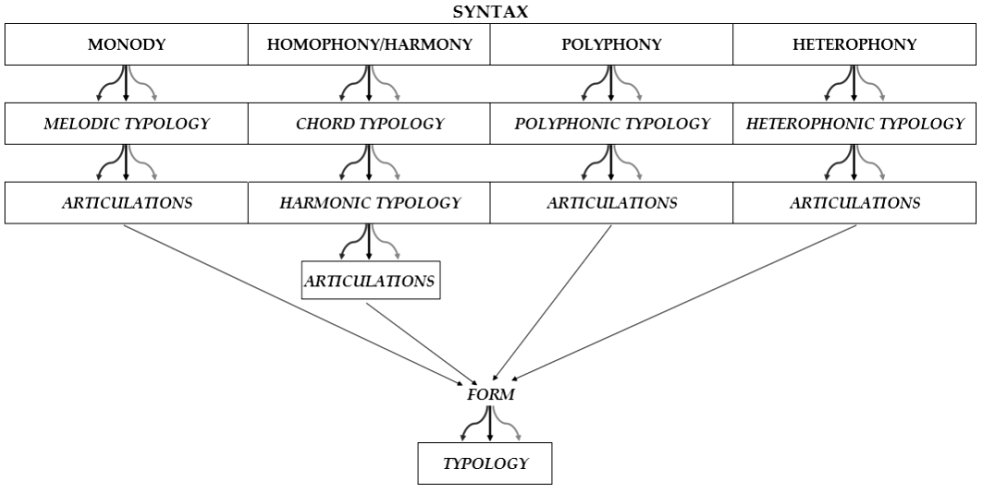

Fig. 2b. Syntactic Analysis Diagram.

Like any theory, the proposed method of analysis is to be validated through its practical application. It is perfectible and lends itself to creating algorithms, possibly it can be the basis of a software.

3 Analysis Example – *Sfârleaza* [*The Spinning Top*] by Anatol Vieru

Anatol Vieru is one of the important composers of the post-war generation. His musical thinking is grounded and, at the same time, falls within an "artificial" neomodalism (as Irinel Anghel[8] calls it). Thanks to the theorization of this system of thought in the *Book of Modes*, Moreno Andreatta[9] places Anatol Vieru in the company of two other great musicians: Milton Babbitt and Iannis Xenakis. The three find themselves in an area that interferes with mathematical thinking.

The author presents his cycle of miniatures as follows: "The 20 miniatures *The Children's World* were composed in Moscow in 1958 [Figure 3]. I lived with my wife and daughter in one room; Lena had just turned one and this music was a family order; the cycle describes the toys and a day in her life. But the miniatures are at the same time the composer's modal toys: the children's day that begins with the piece *In the Morning* and ends with *At the Gates of Sleep* unfolds in parallel with an evolution of the composer. Leaving Messiaen's symmetrical modes, he approaches less common scales, rebarbative but fecund for modal operations; an approach, which, in years to come, would lead the composer to other fields."[10] It is not a singular situation. For many composers, piano creation was the laboratory where they experimented with compositional techniques or their own musical languages. From this perspective, all 20 pieces are worth analysing.

[8] Anghel, *Orientări, direcții, curente ale muzicii românești*, 61.
[9] Andreatta, *Méthodes algébriques en musique et musicologie du XX^e siècle*.
[10] Vieru, *Anatol Vieru despre muzica sa*, 104.

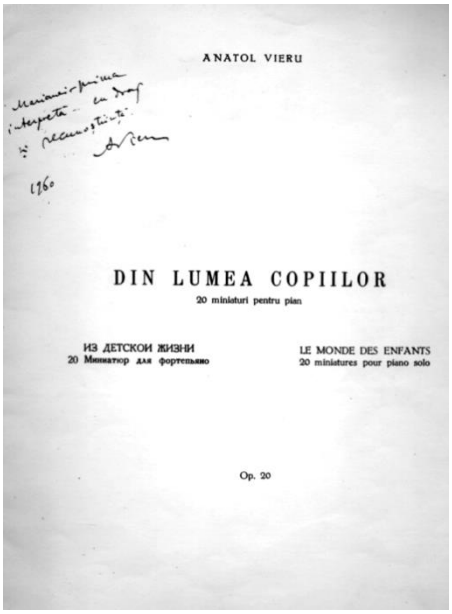

Fig. 3. Anatol Vieru, *The Children's World*, title page with the composer's autograph.

3.1. Sfârleaza – *Morphological Analysis*

Anatol Vieru's musical thinking has, among others, two important pillars: mathematics and modalism. Of all the miniatures in *The Children's World* cycle, *Sfârleaza* in particular caught my attention due to the suggestive force of the movement made with simple means and the beauty of its composition.

i. To study the sound material I employed the method developed by the author in the *Book of Modes*, i. e. the modelling in subgroups of the group $\mathbf{Z}_{12}$ endowed with an additive composition law. The operations applied to subsets are the usual ones in set theory (union ∪, intersection ∩, etc). For the graphic representation we use the chromatic circle. At first glance, it seems that the author uses the chromatic scale. But on closer analysis we distinguish several defective modes each used in a section of the piece of music.

The work begins with a mode A = {3, 4, 7, 8} which is the "negative" of the chord D – F♯(F) – A. There is an ambiguity here that is clarified only at the end of the piece. The chord frames the mode but is absent, as if clipped (a sort of cutting up) [Figure 4]. Notice a symmetry of the two semitones that frame the minor third. This mode only appears in measure 1.
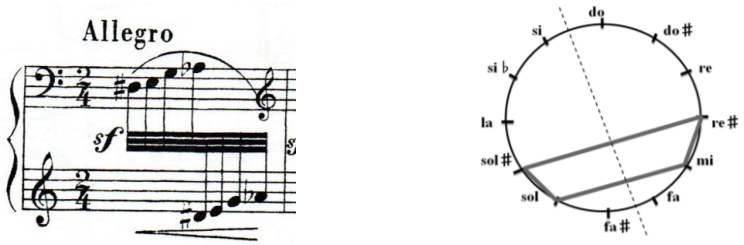
Fig. 4. Anatol Vieru – *Sfârleaza,* mm. 1, mode A.

In measures 2-24, another mode B = {0, 1, 10, 11} follows (Figure 5). This is a chromatic mode, a compact cluster of four sounds shared between sound planes in two ways:

1. B-C/ A♯-D♭ in measures 2-16
2. C-D♭/A♯-B in measures 17-24

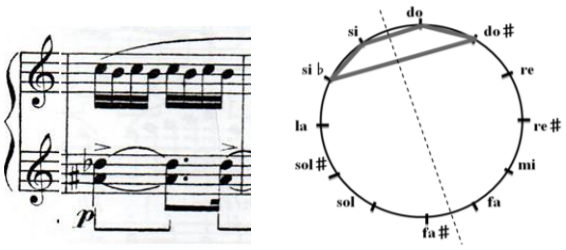

Fig. 5. Anatol Vieru – *Sfârleaza,* mm. 10, mode B.

The section between measures 25 and 38 contains another mode: C = {0, 1, 2, 5, 6, 9, 10, 11}. This is obtained from the B mode by adding the D-F♯-A major chord and the D-F-A minor chord [Figure 6].
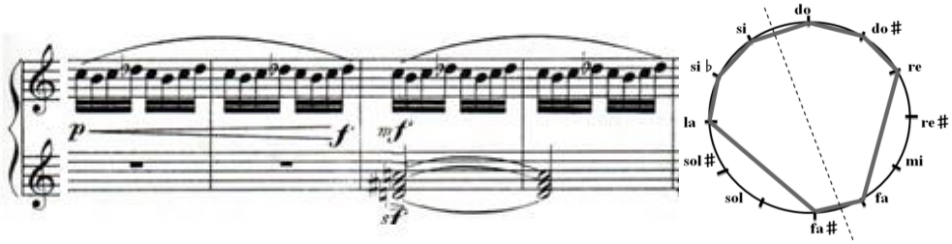
Fig. 6. Anatol Vieru – *Sfârleaza,* m. 25-28, mode C.

The three modes interact in an interesting way. Thus, A and C are disjoint (A ∩ C = Ø, have no common element), they form a partition of Z_{12} (A ∪ C = Z_{12}), and B is a subset of C, (B⊆ C). For all there is an axis of symmetry (in the geometric sense) and not in the sense later defined by Vieru. It passes through the middle of the semitones B-C, respectively F-F♯.

Between measures 39 and 46 a polymodality can be detected. The two sound planes are independent and we have D = {0, 1, 2, 3, 4, 8}, respectively E = {3, 7, 8, 9, 10, 11} [Figure 7]. In both cases there are two sound axes D, G♯ (mode D), respectively D♯, A (mode E).

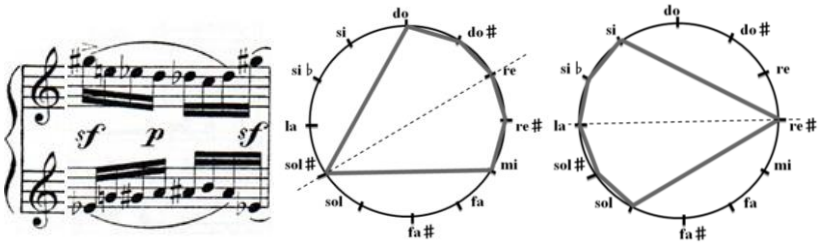

Fig. 7. Anatol Vieru – *Sfârleaza,* m. 39, modes D and E.

The last section reveals the chord absent from the beginning. It is established along four measures. A sound pattern is added in which we recognize the beginning of the piece.
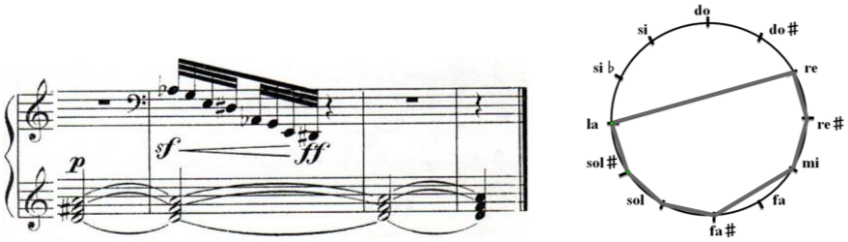
Fig. 8. Anatol Vieru – *Sfârleaza,* mm. 47-50, mode F.

ii. The "melodies" that emerge from these modes are chromatic and minimalistic. From measure 2 to measure 24 we note two floating, static planes. Contrary to expectations, the end result is by no means monotonous. The dynamization of the discourse is achieved in three ways in the three subdivisions of the section:

a) measures 2-9 – through the rhythmic variation of the mobile evolutionary pattern;
b) measures 10-14 – the emergence of the harmonic interval of a double diminished fourth (also a mobile evolutionary pattern) superimposed on a fixed reiterated formula;
c) measures 17-24 – the previous fixed pattern is transformed into a mobile non-evolutionary pattern by transposition to a semitone and superimposed with its inversion.

Starting at measure 25 and up to measure 38, melodic cells appear in which the movement increases. The range is enlarged through the appearance of chords and their leaps. The section is a palindrome whose axis of symmetry is at the beginning of measure 32 [Figure 9].
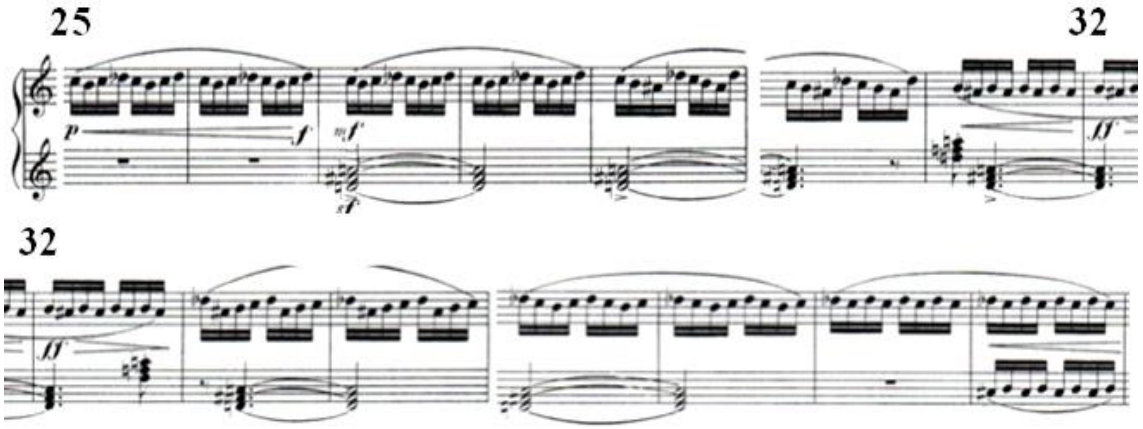
Fig. 9. Anatol Vieru – *Sfârleaza,* mm. 25-38.

Next, up to measure 47, we notice a pattern and its inversion, the two evolve through the progressive elision of the last sound and then the return in recurrence, also progressively, to the initial form, and forming a palindrome with the axis of symmetry before the last eighteen measure 42 [Figure 10].
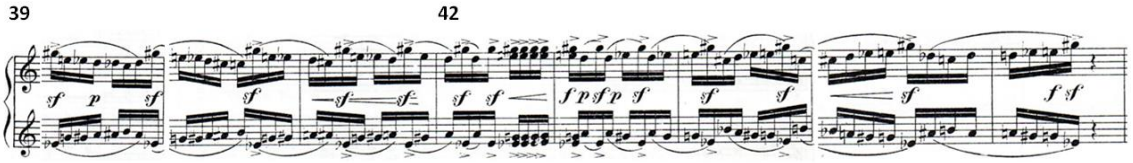
Fig. 10. Anatol Vieru – *Sfârleaza,* mm. 39-46.

iii. The composer also experiments rhythmically. In each of the sections that are already distinguished by musical scales and melodies, he creates the illusion of a series of accelerations and decelerations. Thus, there are:

a) metric rhythm – measures 2-9 and symmetrical measures 17-24 – the acceleration is done within the measure but with the change of pulsation from eighths to tuplets, then to sixteenths grouped by 4 and decreasing to 3, respectively to 2 [Figure 11]; deceleration follows the same path in reverse. Between the two segments, the composer inserts another non-retrogradable rhythm.
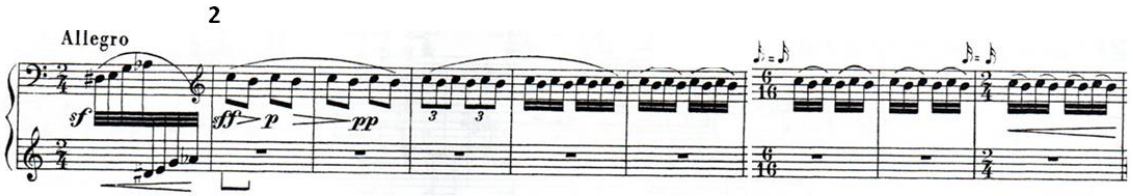
Fig. 11. Anatol Vieru – *Sfârleaza,* mm. 1-9.

b) non-retrogradable rhythm with rhythmic diminution and augmentation in progression by removing or adding a sixteenth in measures 10-16 [Figure 12], but also in measures 39-46 in legatos [see Figure 10].
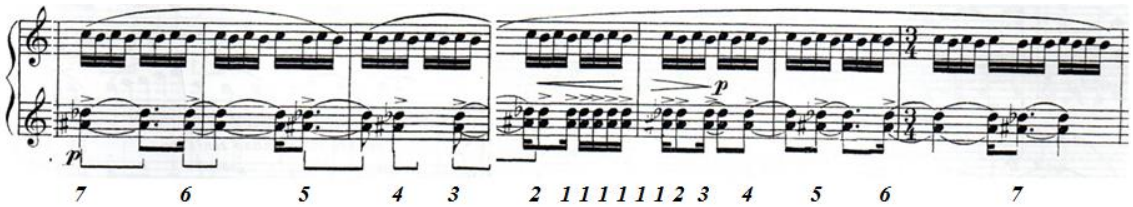
Fig. 12. Anatol Vieru – *Sfârleaza,* mm. 10-16.

iv. Regarding the metre, Anatol Vieru applies two different strategies in the two halves of the miniature:

a) in measures 1-24 – he changes the beat patterns: $^{2}_{4} - ^{6}_{16} - ^{2}_{4} - ^{3}_{4} - ^{2}_{4} - ^{6}_{16} - ^{2}_{4}$. There is also a symmetry of the succession of measures here, but it is not rigorous in terms of the number of measures.

b) starting with measure 25 and until the end it remains $^{2}_{4}$.

v. The tempo is fixed – an Allegro without any mobility. The illusion of movement is achieved through rhythm with the help of sometimes progressive, sometimes abrupt dynamics. The image below reproduces the sonogram of the song obtained with the help of the *Audacity* software [Figure 13]. It reveals the dynamic profile of the work. The local

climaxes can be seen and, much as a surprise, it is not the *ff* of measure 32 that is the climax of the work but the second beat of measure 42.

Fig. 13. Anatol Vieru – *Sfârleaza,* Sonogram.

vi. As it is a work dedicated to the piano, the timbre is monochrome. But it is not monotonous. Attacks on the legatos of variable lengths, together with the dynamics and the pedal create a vibrant sound colour, the coincidence of the rhythmic accents with the changes of the sound spectrum can be noticed. The image below is the spectrogram obtained by means of the *Sonic Visualiser* [Figure 14] The greater density of the higher harmonics overlaps the high points – the higher verticals. On the other hand, there is a compact layer in the lower part that proves the presence of a uniform sound mass, continuous up to the final chord.

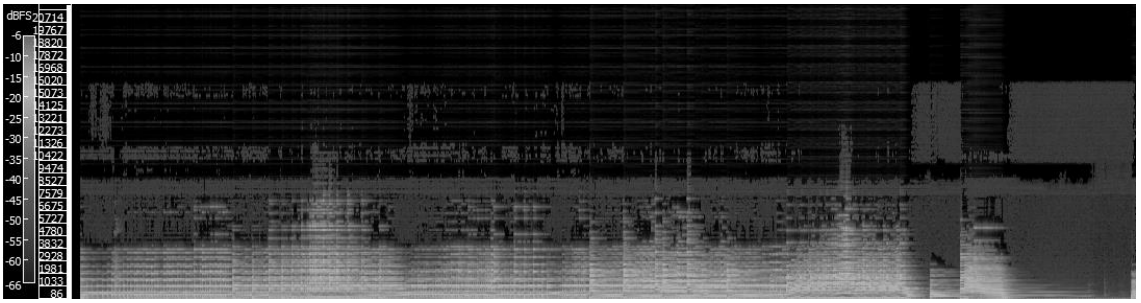

Fig. 14. Anatol Vieru – *Sfârleaza,* Spectrogram.

vii. The texture is compact from the beginning to measure 38 even though the two sound planes are disjoint (they have no common elements). Further along it becomes porous. The discontinuities of the lower sound plane (in the left hand) do not affect the continuity of the musical flow.

viii. The seemingly static music is built on a transformational ostinato. One can find, in segments, melodic obstinacy, but also rhythmic; in some places there are transformations of the obstinate formula. All can be easily seen in the musical examples presented above.

We went through all the steps of the algorithm for analysing the morphology of the piano miniature composed by Anatol Vieru, respecting the sequence of parameters according to the theoretical model. This ensures that we haven't missed any parameters, and for each step the way of working has adapted to the score.

3.2. Sfârleaza – *Syntactic Analysis*

The work is small in size and therefore does not allow for large architectural developments. Being composed for piano, the probability of monodic writing is (generally) almost nil, and it is zero in our case. It follows that there is nothing to research in this direction. Harmony is mainly inherent in the overlapping of sound planes. The exception is represented by the emergence of major and minor chords, respectively the homophonic writing in the middle section. Articulations are made by changing modes and melodic outline. The work has an obvious polyphonic character proven by the use of contrapuntal techniques of inversion and recurrence.

The form may be interpreted as a simple ternary form, specific to piano miniatures. However, it can just as well be interpreted as a two-part form with a short reprise. The last section is a melodic variation of the rhythmic palindrome of the first section. Still, I opt for the ternary form. The argument that tilts the balance in favour of this option is the presence of three (vertical) axes of symmetry. They coincide with the climaxes and are placed in measures 13, 32 and 42. Another argument is the contrasting character of the homophonic middle section (measures 25-38) compared to the other two polyphonic ones, obviously related. Both the sonogram and the spectrogram support this choice. The structure of the piece is shown in the table below (Table 1). In addition to highlighting the sections, I noted the palindromes numerically (1 = one sixteenth) and their typology: rhythmic in the first section, harmonic in the second and polyphonic in the last.

Measure	1	2	25	39	47-50
Section	Introduction	A	B	A’	Coda
Symmetry		7-6-5-4-3-2-1-1-1-1-1-1-2-3-4-5-6-7	8-7-1-6-1-7-8	7-6-5-4-3-2-1-1-1-1-1-2-3-4-5-6-7	
Typology		Rhythmic	Harmonic	Polyphonic	

Table 1. Anatol Vieru – *Sfârleaza* – structure

Anatol Vieru combines the rigor of mathematical thinking (equally numerical and geometric) with musical expressiveness, in the present case he very suggestively evokes the rotation movement of the spinning top. The composer joins contemporary elements such as artificial modes and non-retrograde rhythms with elements from the tradition of scholarly music such as the 2/4 metre and the major chord. *Sfârleaza* (and the whole cycle *The Children’s World*) is among the works that prepared the ground for shaping the mature style and innovative musical thinking that places Anatol Vieru among the important composers who influenced the composition of the 20th century.

4 In Lieu of Conclusion

The present material represents an intermediate stage in the development of an analysis method adapted to the musical repertoire of the twentieth century, but also to current interdisciplinary trends. It responds to a personal but, at the same time, didactic need. The knowledge and integration of the results reached by other musicologists together with the exploitation of the possibilities offered by computer technology are the elements we rely on in the further development of the presented method. The analysis example was specifically chosen to use a good part of the available working options and demonstrate the effectiveness of the method. The matrices designed for both morphology and syntax ensure the stability of the method by not leaving any important aspect out of the analysis. The freedom of movement within them gives an eclectic aspect to the approach, but most of the time, it gives anyone the opportunity to choose the way of working that is more familiar to them or better suits the music to be analysed. In the end what is important is the final result of the analysis and not the path onto which it is carried out. However, sometimes we need a map to guide us. If the method is applied by at least one analyst, then it has achieved its goal.

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